

# MANAGING THE DEVELOPMENT OF HIGH-TECH ENTERPRISES BASED ON FORESIGHTING

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## ABSTRACT

*This paper examines the methodological concept of foresighting a strategy for the innovation development of high-tech enterprises operating within the real sector of the economy. The subject owes its relevance to the fact that traditional (classic) approaches to the strategic management of the operation and development of present-day enterprises within the high-tech sector are failing to align with the latest trends and cannot be used under conditions of non-linearity and stochastic changes within the framework of the current economic cycle and techno-economic paradigm. The inferences derived from this research study substantiate the advisability of using the methodological concept of foresighting for the purposes of strategic planning and managing the development of high-tech enterprises. Based on the findings of this study, the authors come to the following conclusions: foresighting is a relatively new tool for the strategic management of the innovation development of high-tech enterprises. That being said, considering that foresighting may involve the various public forces and employ the various channels for up-and-down communication between the entrepreneurial, scientific and public-governmental spheres, with decisions being focused on the long run, there is potential for a much wider scope of the search for and deployment of strategic benchmarks for the development of high-tech enterprises. The methodological concept of foresighting the innovation development of high-tech enterprises makes it possible to change the strategic adaptive approach to forecasting and planning their activity into the strategic constructive one. Sequential implementation of stages in foresighting makes it possible to determine the outline and alternative dimensions of the innovation development of high-tech enterprises through the use of special technology (horizon scanning and weak signal detection) and conduct the selection of promising projects, which, if implemented, will help achieve the goals set by the company.*

**Keywords:** Innovation Development, High-Tech Enterprises, Strategy for Innovation Development, System of Innovation Management, Foresighting, Foresight Research, Foresight Project, Roadmap, Strategic Management.

## INTRODUCTION

Present-day high-tech enterprises are complex, open, determined and non-linearly developing social-economic systems. Therefore, considering the nature of the systemic approach

to the strategic management of the innovation development of these enterprises, it is worth understanding that any system is a sub-system of a higher-level system (“supra-system”) (Kuosa, 2016; Knyazeva, 2006; Salamzadeh et al., 2012). Consequently, the primary objective in the operation and development of lower-level systems is to facilitate the achievement of objectives for higher-level systems. From this it follows that in managing the innovation development of high-tech enterprises using the systemic approach, it is worth considering that the role of a higher-level system in this case will be played by the system of strategic corporate management of the enterprise and the national innovation system. It is acute comprehension and intuition that many consulting companies see as a key element that links together the company’s objectives for the general corporate strategy and those for the strategy for innovation development (Fahey, 1998; Cuhls & Johnston, 2008).

When it comes to the interrelationship between the corporate general strategy and innovation strategy for the development of high-tech enterprises from the perspective of synergetics (Knyazeva, 2006; Haken, 2000), it is worth pointing up here:

1. First of all, the need to subordinate the company’s innovation strategy to its corporate general strategy;
2. Second of all, the need to cultivate forward and backward linkages between these two strategies.

In this regard, a backward linkage may be a set of adjusting solutions aimed at optimizing the corporate general strategy of a high-tech enterprise factoring in the development of the system of innovation management and, particularly, its key sub-system-the strategy for innovation development (Von der Gracht, Vennemann & Darkow, 2010; Rohrbeck & Gemunden, 2011). The system of innovation management in an enterprise ought to not only ensure the formation of an adequate and potentially implementable innovation strategy through the timely identification of global invariable and variable technological trends-it also ought to be aimed at helping forecast trends in its development and construct scenarios of a desired future.

When it comes to philosophical grounds for constructing the future of high-tech enterprises, it is worth noting here three crucial aspects: “the image of the future”, “an alternatively possible future” and “creating the future-not predicting it” (Knyazeva, 2006). While under the synergetic approach one may need to complement these crucial aspects with a shift from the adaptive model for strategic management to the constructive one, predicated on cognitivizing managerial activity (this approach is also termed ‘proactive’), which, above all, makes it possible to not only construct alternative scenarios of future development but facilitates the actual participation of high-tech enterprises in creating (actualizing) the desired image of the future in present reality. That being said, data obtained as a result of constructing the image of the future may serve as a basis for effecting changes in the corporate general strategy, i.e., in essence, the image of the future of high-tech enterprises is a force that drives development through the use of innovations and scientific-technical achievements as the basis.

This article has a traditional for scientific research publications IMRAD format (introduction, methods, results and discussion). The relevance and significance of the study is substantiated in the Introduction, the methodology for statement and performance of the study, as well as the data sources used in the article, are described in the Methods section. The Results section reflects the trends of high-tech development of the economies of the USA, the European Union and the Russian Federation, as well as a theoretical and methodological analysis of the evolution of scientific approaches to the study of the future complex socio-economic systems. The authors’ theses and hypotheses on the practical use of the foresight technologies (as the

future research tools) are presented in the Discussion section. The Conclusion section summarizes the final provisions of this article.

## METHODS

This article is a content analysis aimed at the unification of the methodical approaches to application of the foresight design for the purposes of strategic planning and management. The content analysis includes two lines of study:

1. The first line concerns the evolution of the theory of management and planning, which makes it possible to construct the theoretical and methodical transitions in the scientific paradigm for the study of the future of complex socio-economic systems based on a comparison of the forecasting and planning tools;
2. The second line concerns the empirical aspect and practical use of the methodological tools for designing the future complex socio-economic systems. It gives the opportunity to structure and describe the foresight technologies most applicable in the practice of managing complex socio-economic systems.

In the empirical context, one of the commonest tools for constructing the image of the future and an alternatively possible future is a foresight project. Researchers have noted the growing need to use foresighting as a tool for strategic planning, which needs to be utilized to help ensure the competitiveness of high-tech enterprises in the long run (Battistella, 2014; Kuosa, 2010). Foresighting could be construed both broadly and narrowly. In a broad sense, foresighting is viewed as systematic attempts to assess the long-term prospects for science, technology, economics and society with a view to determining the strategic dimensions of research and new technology capable of ensuring the biggest social-economic benefits (Coates et al., 2001). In a narrow sense (including in the context of strategic management of the development of high-tech enterprises), foresighting may be viewed as a way or method of organizing a process aimed at creating in participants a common vision of the future, which all interested parties will strive to uphold with their today's actions (Kaserer, 2015). Certain research studies have identified a distinction of foresighting from earlier methodological approaches to forecasting and planning the development of high-tech enterprises, whereby one of the key ideas underlying foresighting is describing not the actual image of the future but specific actions aimed at creating it (Vecchiato & Roveda, 2010).

The official publications of the Federal State Statistics Service of Russia and the Organization for Economic Cooperation and Development (OECD) are used as the sources of analytical and statistical data. These sources are reliable, since the information published by them and the data are confirmed by the research of independent international consulting companies.

## LITERATURE AND RESEARCH REVIEW

There are quite many scholarly and empirical publications out there exploring the characteristics of applying the methodological concept of foresighting in strategic planning and managing the innovation development of enterprises, including those operating within the high-tech sector. These normally seek to determine the key specificity of foresighting, which ultimately consists in its participants taking an active part in influencing the implementation of preferable scenarios of future development (Dudin, Lyasnikov, Pankov & Sepiashvili, 2013; Kuosa, 2016; Cuhls & Johnston, 2008). Foresighting and foresight research may be implemented at various hierarchical levels within national innovation systems namely:

1. The global level (conducting foresight research into and designing the future of transnational corporations, as well as major economic and financial international institutions);
2. The national level (conducting foresight research into and designing priority areas and dimensions for the scientific-technical development of the national economy);
3. The sectoral level (implementing foresight projects in specific industries and areas within the real or financial sector of the national economy, as well as at the level of research-and-production and research-and-technology clusters);
4. The corporate level (implementing foresight projects at the level of high-tech enterprises).

Examined most widely in the literature are issues related to utilizing foresighting at the national or sectoral level (Kuosa, 2010; Kuosa, 2016; Ruff, 2006). That being said, many scholars are pointing out the possibility of using the methodological concept of foresighting as part of the shift from raw materials-based to high-tech development in transitive economies (Dudin, Sepiashvili, Smirnova, Frolova & Voikova, 2015; Mendonça, Pina e Cunha, Kaivo-oja & Ruff, 2004). The findings of certain scholarly works suggest that it may also be possible to postulate the orientation of foresight projects to boosts in the efficiency of the national and global innovation system in the long run. As a rule, key objectives for foresighting are established in the following way:

1. Determining and structuring the priorities for scientific-technical development (global, national, sectoral or corporate);
2. Ensuring the development of interrelationships between the various elements of national innovation systems, as well as fostering their interaction with the global innovation system;
3. Creating relevant plans and programs for the development of social-economic systems (corporate, sectoral, national and global) by reference to specific scientific-technical priorities.

In recent years, the major focus in the literature and empirical research has been on the implementation of foresight projects with a view to ensuring the competitiveness of entrepreneurial establishments and the development of “foresight organizations” (Dudin et al., 2015). Scholars and researchers have on numerous occasions provided a rationale for the effectiveness of utilizing foresighting as a tool for developing and adjusting the corporate general strategy, as the potential of this instrumentation appears to be meeting the needs associated with the strategic management of present-day high-tech enterprises (Vishnevskiy & Karasev, 2016; Vishnevskiy, Karasev & Meissner, 2016). Implementing corporate foresight projects in high-tech enterprises may be associated with:

1. The independent conduct of foresight research (e.g., when there is a lack of global and sectoral foresighting) enlisting the services of external participants: members of the executive, members of the scientific community and members of public and civil organizations;
2. The participation of high-tech enterprises in sectorial, national or global foresight research, which also presupposes the subsequent adjustment of the corporate general strategy and innovation strategy for the development of those enterprises;
3. The adaptation and adjustment of the results of global and national foresight research by reference to the latest conditions and limitations of the national innovation system, which, likewise, also presupposes the subsequent adjustment of the corporate general strategy and innovation strategy for the development of high-tech enterprises.

Current research focuses on 6 fundamental principles of foresighting, which, in the authors’ view, could be utilized with respect to any form of foresight research and foresighting the innovation development of high-tech enterprises (Rohrbeck & Gemunden, 2011; Battistella, 2014; Coates et al., 2001; Kaserer, 2015).

The first principle is the principle of public force engagement, which consists in engaging in foresight research and foresighting members of small, medium and large entrepreneurship, the

state, scientific, public and civil organizations and experts specializing in the various scientific-technical areas.

The second principle is the principle of communication, which implies organizing network interaction between foresight participants in the process of developing and conducting foresight research.

The third principle is the principle of concurrence, which lies in the need for the coordinated work of all participants in foresight research and foresighting. This kind of work ought to be aimed at achieving consensus based on multiple views, expert assessments and developed scenarios of future scientific-technical development.

The fourth principle is the principle of focusing on a long period in the development of the study's subject. As a rule, in foresighting the forecast horizon is no less than 20-50 years (depending on the scale of the activity and the specificity of the operation and development of the study's subject).

The fifth principle is the principle of coordination based on the convergence of interests. This principle consists in the need to factor in economic and social changes in the process of establishing the priorities for scientific-technical development, as well as the need to assess their effect on social-economic development.

The sixth principle is the principle of systemicity, which implies organizing the foresighting process via structuring multiple expert opinions and assessments, which may also be interpreted ambivalently.

On the one hand, the approach to forming a consensual image of the future and fostering the network interaction of participants as part of foresight projects helps reduce uncertainty and coordinate the strategies and joint actions of the various participants in the innovation system.

On the other hand, the excessive narrowing and reinforcing of network linkages between the participants may result in path dependency, which may block the alternative variants of future development. The risk of path dependency could be reduced through the search for alternative variants for future development and relevant ways to adapt innovation systems.

## RESULTS

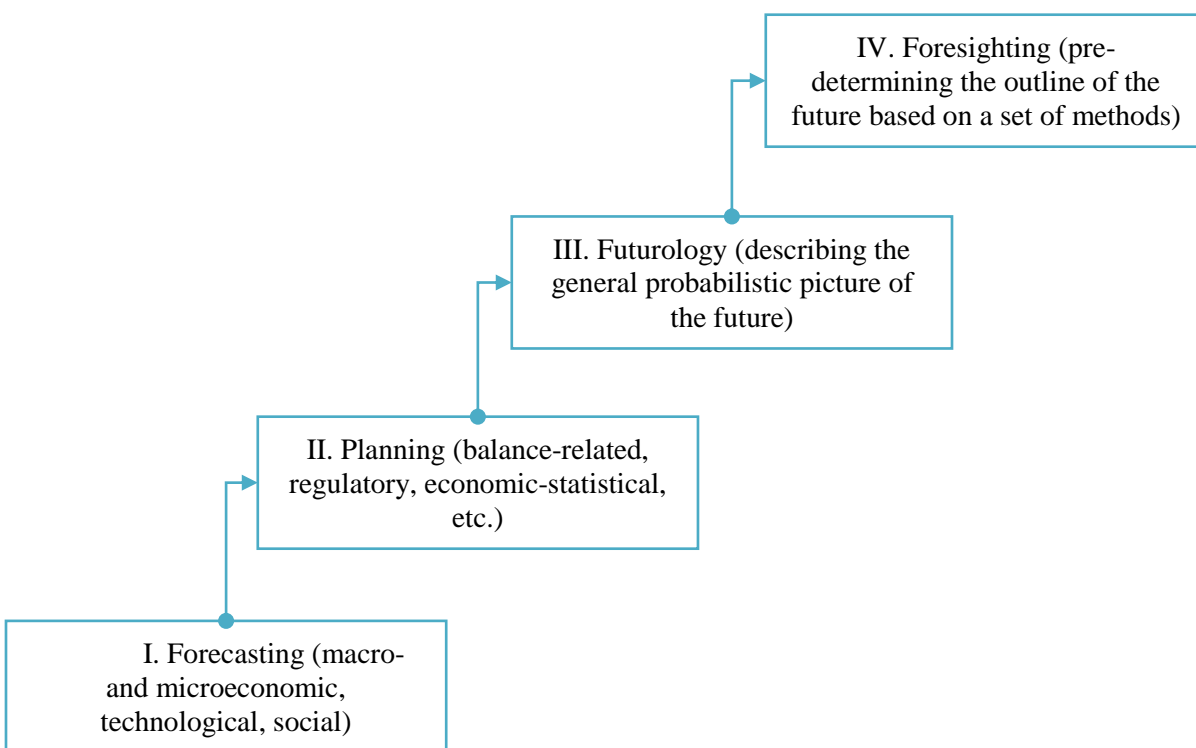
The high-tech sector is the key driver of the economic growth of the countries. However, in order to successfully develop the high-tech activities, the innovation is required (product, process, organizational and marketing). For example, in the Russian Federation the level of innovative activity of the enterprises is not high enough with a tendency to decrease: in 2012, about 10% of all enterprises implemented all kinds of innovations; in 2016 the share of such enterprises was no more than 8.5%. The high-tech exports from Russia did not exceed 1% in the last five years (Rosstat, 2017). On the contrary, in the period from 2012 to 2016 inclusive in the US and the European Union (EU-15) the innovative activity of enterprises was around 15-20%, while the total high-tech exports from these countries for the same period was about 30% (OECD, 2016). It is obvious that Russian managers need to reform the approaches to strategic planning and management of the enterprise development, including those integrated into the medium and high-tech manufacturing sector of the national economy.

Over the last 2-3 decades, the scientific methodology of strategic management and planning of the development of high-tech enterprises has undergone significant changes:

1. Firstly, national economic systems and the global economy are passing through the "post-industrial barrier", which creates additional threats and risks for sustainable-economic development and well-balanced economic growth;

2. Secondly, it has been shown that there are three critical zones that determine the non-linearity, stochasticity and dynamism of the changes occurring (the natural, technological and social environment);
3. Thirdly, amid the current extreme uncertainty, utilizing traditional tools for strategic planning and management no longer implies formulating an adequate and commensurate path for the development of high-tech enterprises.

Therefore, it is objectively necessary to use the latest tools for constructing the future of high-tech enterprises while relying on previously accumulated scientific and empirical experience of strategic planning and management. The authors view forecasting, planning, futurology and foresighting as 4 logically successive approaches to exploring the future of complex social-economic systems (i.e., including high-tech enterprises). Figure 1 illustrates 4 sequential transitions in the development of tools for exploring the future of complex social-economic systems.



**Figure 1**  
**FOUR SEQUENTIAL TRANSITIONS IN DEVELOPING RELEVANT TOOLS FOR EXPLORING THE FUTURE OF COMPLEX SOCIAL-ECONOMIC SYSTEMS**

Forecasting the operation and development of social-economic systems (in our case, enterprises within the real sector of the economy, including those operating within the high-tech sector) may be viewed as one of the first tools to have been founded on scientifically-substantiated procedures, with the mathematical methodological framework used actively. Forecasting forms the basis of planning the activity of enterprises. Yet, at the same time it is worth noting that starting in the last quarter of the 20<sup>th</sup> century the strategic planning systems of most enterprises (including those operating within the high-tech sector) have relied much less on forecast data and much more on manager intuition. This is due to the fact that with the

acceleration of scientific-technical progress and globalization processes the credibility of forecasts (both macro- and microeconomic) has been diminishing, as these forecasts have not been taking into account specific latent changes, as well as weak signals, localized in the environment. As a consequence, enterprise development plans drawn up based on such forecasts have been failing to ensure achieving desired results and implementing these plans has not been leading to the attainment of strategic target benchmarks for development (Dudin et al., 2015).

The diminishing trust in forecasting and strategic planning has provided a rationale for demand for new tools for the systematic exploration of the future, which initially were combined under the general term “futuresology” (or “futuristic”). The futuresological approach to describing the future has encompassed all areas and aspects of life activity in modern human civilization, being based, above all, on exploring specific scientific-technological trends in and laws governing social development. The major purpose of futuristic research is global forecasting, which is predicated on the synergetic approach and the capacity of large social-economic systems for self-organization (Kuosa, 2016; Ruff, 2006).

It is worth regarding foresighting as the most optimal tool for the systematic exploration of the future, which can be adapted to suit the needs of the micro economy (the economy of enterprises). That being said, foresighting cannot be identified with routine forecast procedures and planning procedures (Vishnevskiy & Karasev, 2016; Kaserer, 2015), since it also employs the synergetic approach and presupposes not so much establishing specific targets as establishing specific indicators or qualitative benchmarks within the strategy for the development of modern, including high-tech, enterprises, with a view to determining the desired outline of their future. It is for this reason that the authors find it worthwhile to explore the methodological concept of foresighting the innovation development of modern high-tech enterprises in a bit more detail.

## DISCUSSION

Among the key characteristics governing the success of foresighting is diversity, i.e. the quality of being heterogeneous, variable and dissimilar, which is in alignment with the present-day requirements associated with the development and evolution of national innovation systems that are flexible and capable of adapting based on changes in the external environment. The diversity quality is manifested in all the components of foresighting:

1. A broad array of tools and research methods for organizing foresight projects;
2. Multitudes of various standpoints and dissimilar views being covered;
3. Various elements of the innovation system being engaged in the process;
4. The diversity of objectives for conducting foresight research and developing relevant projects.

The diversity of participants engaged, tools and methods employed and expert opinions and variants of subsequent innovation development considered helps go beyond the limits of the development path established by the economic strategy for deriving profit and restricted by existing standards and dominating concepts and practices. That being said, it is worth understanding that in practice the shift from adaptive to proactive management of the development of high-tech enterprises normally takes place only when there are conditions under which earlier business models are no longer conducive to the attainment of goals set and achievement of end-results planned. That being said, from a scientific standpoint, this approach may increase the risk of the high-tech enterprise getting caught in the inertia “trap”. Enterprises taking part in sectorial, national, or global foresighting or organizing foresight projects of their own get the opportunity to foresee ahead of time the signs of changes and construct desired variants of further development which go beyond the path of their existing corporate strategy for development and strategy for innovation development.

Of late, the literature (Popper, 2012) has mainly focused on the following 2 promising areas for foresight research: “horizon scanning” (monitoring and analysis of nascent trends) and “weak signal detection” (these signals, normally, indicate the first signs of radical changes that will occur in the future). It has been suggested to construe weak signals as various hard-to-trace indicators of future radical changes in trends in scientific-technical development. Research by Brummer, Konnola & Salo indicates that the “weak signal scanning” method is grounded in the aspiration to factor in various views of the future. That being said, the subjective characteristics of “weak signals” may lead to revealing an excessively broad array of events that do not lend themselves to systematic analysis and the identification of interrelationships between them, which complicates the expert assessment of the degree to which they influence the development of new trends (Brummer, Konnola & Salo, 2010). A possible solution here may be selecting signals that reflect specific ideas about potentially promising innovations (Mendonca et al., 2004; Kuosa, 2010).

Foresighting the innovation development of high-tech enterprises should not be limited just to horizon scanning and weak signal detection. Corporate foresight projects or foresighting the innovation development of enterprises comprises 6 major stages (Dudin et al., 2013). The first stage involves the qualitative assessment of global invariable civilizational trends in development (changes in the political situation; major areas for social-economic and scientific-technological development). Here, one selects innovation ideas and solutions which, looking ahead, are capable of transformation and development in alignment with global invariable trends.

The second stage established priority areas for the innovation development of a high-tech enterprise by reference to its innovation potential. An optimal solution may be concurrently developing the foresight project and putting together or adjusting the corporate general strategy, the strategy for innovation development and other functional strategies (financial, investment, marketing, HR, etc.). This stage results in having developed a strategy for the company’s innovation development and a set of functional plans coordinated with it in sync with the corporate general strategy.

The third stage in organizing a foresight project consists in developing alternative scenarios of development that are based on the analysis of the internal and external environment, identified trends in macroeconomic development and specific priorities for the company’s strategic development, based on which one establishes one outline (chief) scenario and a set of additional scenarios for possible changes in political trends and those in society’s social-economic and scientific-technological development. This stage results in a set of scenarios that describe using proper terminology the structure of the development of the system of innovation management capable of ensuring the competitiveness of the high-tech company in the long-run.

Subsequently, to select potentially promising innovation ideas and projects within the context of particular scenarios, one may apply the method of screening robust portfolio models (Brummer et al., 2010), which involves:

1. Foresight research participants putting together a pool of innovation ideas;
2. Conducting joint expert assessment and iterative adjustment of innovation ideas which can be put into effect technologically;
3. Conducting multivariate criteria assessment of innovation ideas based on certain scales and gradations;
4. Conducting multivariate criteria portfolio analysis to identify trends, “weak signals” and “noise”.

In the course of the multivariate criteria portfolio analysis, one puts together, based on previous assessments, portfolios of innovation ideas (or “project portfolios”).



At the next stage, one assesses the degree to which high-tech enterprises (their systems of innovation management) are prepared to carry into effect their developed design scenarios and alternatives to them based on corporate methodologies developed specifically for the purpose. This stage results in correlating the current development level of the high-tech enterprise, its capabilities and its preparedness to implement its developed scenario alternatives, capable of ensuring its strategic competitiveness and putting together a foresight project and roadmaps that establish possible areas for refining projects selected as a result of screening robust portfolio models and working out plans for the implementation and development of projects.

The final stage involves developing a set of procedures for the control and monitoring of the implementation of the developed foresight project and roadmaps. Notwithstanding that the authors have established above a specific sequence of stages in foresighting, a key characteristic here is the possibility of making relevant changes and going back to any of the stages at any point in time (European Commission, 2012).

Foresighting the innovation development of high-tech enterprises may involve specific methods and sets of methods that were in wide use around the world and utilized successfully prior to the emergence of the foresight methodological concept for long-term forecasting and planning. However, the application of these methods in foresighting is distinguished by the use of the systemic and synergetic approach to their integrated implementation, which ensures alignment with the above major principles in investigating and constructing the image of the future and developing an action plan for attaining it.

The specificity and characteristics of the use of particular methods and tools employed as part of the methodological concept of foresighting have been described quite sufficiently in scholarly works and those by science journalists. Therefore, when it comes to general strategic approaches to foresighting the innovation development of present-day high-tech enterprises, it is worth focusing on just those that are in the widest methodological use today, namely:

1. Brainstorming;
2. Expert panels;
3. Conducting interviews;
4. Scenario building method;
5. Delphi method;
6. Method of screening robust portfolio models.

This roster of methods used in foresighting the innovation development of high-tech enterprises is by no means final and exhaustive, as the scientific fundamental and applied foundations of foresight research are continually being supplemented and evolving.

First of all, it should be noted herein, that the foresight technologies are applied not only in the economy, but also in public administration. The authors believe that the next evolutionary transition, related to the development of the scientific paradigm for the study of the future of complex socio-economic systems, will be connected with the convergence of macro managerial and micromanagement tools. In general, such a concept was proposed by Itskovich and his coauthors (The "Triple Helix" model) and is currently considered as the institutional basis for post-industrial development in the countries of North America and the European Union (Leydesdorff & Etzkowitz, 1996). As for Russia, the issues of formation of the institutional environment for high-technology development remain relevant and unresolved. This thesis is confirmed by a number of other studies conducted by the well-known Russian scientists and economists (Glazyev, 2016; Kudrin, 2014).

The second practical moment of application of the foresight technologies for future research, which the authors would like to draw attention to, is that it is important to predict not only the regularities that are caused by the unchanged trends, but also the events that have low probability of occurrence: the so-called joker-events or "black swans" (Ray, 2012). However, the power of the influence of such events is very high and, as a rule, these events that arise in the field of politics exert strong influence on society, the economy, the dynamics and the quality of technological progress. For example, during the period of the Soviet statehood, Russia was focused on military-space technologies, in which it was in the lead. But along with this, the technologies aimed at the production of consumer goods of daily demand and durable use (cars, household appliances and electronics), as well as the necessary equipment for creating such goods, were practically undeveloped. After the political collapse of the USSR (which was expected on the one hand, but was of low probability, on the other hand), the Russian market was filled primarily with the imported household products, cars and production equipment. Currently, high-tech products and the equipment form almost half of Russian imports. Therefore, the foresight technologies for studying the future of complex socio-economic systems of macro- and micro level are very relevant for the current economic reality and the field of public administration in Russia.

## CONCLUSION

To summarize, foresighting the innovation development of high-tech enterprises is a modern, effective and sought-after managerial tool that makes it possible to:

1. Detect and identify in a timely manner the "weak signals" of upcoming changes (mainly of a scientific-technical and technological nature), which helps escape systemic "traps";
2. Develop potentially implementable programs for the long-term development of enterprises under conditions of uncertainty and do so with a certain predetermined likelihood of getting them implemented successfully;
3. Create a conceptual image of the company's future under conditions of an optimal rate for its innovation development;
4. Foster network interactions within the framework of the national and innovation system, including via the accumulation of relevant fundamental and applied knowledge.

Corporate foresighting, in a general sense, consists in accumulating information, data and knowledge necessary for the innovation development of high-tech enterprises, followed by transforming these, via management competencies, into unique competitive advantages. The use of foresight projects to ensure the innovation and competitive development of high-tech enterprises is in alignment with the present-day scientific-managerial paradigm, which is predicated on the systemic-synergetic approach and makes it possible to factor in poorly forecasted stochastic changes in global civilizational trends.

This paper has not addressed any of the methodological issues related to assessing risks and threats taken into account in foresighting the strategy for the innovation development of high-tech enterprises. The authors intend to examine the risk-related methodological aspects of foresighting in some of their future papers.

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